

As the species are probably related to the Sponges, as suggested by Huxley, they have considerable interest, and especially the *Sphærozoa*, which, like most Sponges, seem to have the power of secreting silica. The extent to which the ocean, over an area of many square leagues, was crowded with them, suggests that such floating Sponges may have been, in past time, of geological importance as one of the sources of silica for the flint or hornstone and siliceous petrifications of ancient limestones and other rocks.

These species received from the author but a partial study, as those of another class (oceanic Crustaceans) were engaging his attention at the time. The above figures and descriptions are from coloured drawings made on the spot, and from the notes accompanying them.

VII.—On the *Animals of Raphaulus, Spiraculum, and other tube-bearing Cyclostomacea*. By WILLIAM T. BLANFORD, A.R.S.M., F.G.S.

No one can have examined carefully a collection of the operculated land-shells of India and South-eastern Asia without remarking the peculiar shelly processes of the peristome or suture which characterize several of the genera. Two principal forms of these processes may be distinguished, viz. (1) sutural tubes, either open at both ends or closed at one extremity, as in the genera *Raphaulus*, *Spiraculum*, *Opisthoporus*, *Alycaeus*, &c.; or, (2) incisions in the peristome—simple, as in *Pupina*, *Registoma*, &c., or accompanied by expansions of the outer lip, as in *Pterocyclos* and *Rhiostoma*. So far as I am aware, no soft parts have hitherto been observed, in the animals of any of the above genera, corresponding to the peculiarities of their shelly coverings. During the past two or three years, I have examined carefully the animals of species belonging to the majority of the above-named forms; and in two instances I have ascertained the existence of an organization to which the processes of the shell are adapted, these two cases being in the genera *Raphaulus* and *Spiraculum*, which, although by no means nearly allied, agree in possessing a sutural tube opening both internally and externally.

By the kindness of Baron F. v. Richthofen, I had, some time since, an opportunity of examining the animals of several specimens of the rare *Raphaulus chrysalis*, Pfr., from Moulmein in Burma. The sutural tube in this species opens internally, a short distance from the peristome, by a small longitudinal slit, and then passes outside the suture to the aperture, where it is deflected upwards, and runs vertically for 2 or 3 millimetres on

the exterior of the penultimate whorl, opening to the air at the extremity. I found this tube to be partly lined by a perforated process of the mantle, communicating internally, by means of a passage beneath the shell-muscle, with a very small orifice inside the air-chamber in the neck of the animal, and thus affording free access of the air to the pulmonary cavity, even when the mouth of the shell is hermetically closed by the operculum. The existence of this conformation cannot easily be observed during life*, on account of the manner in which the mantle lines the interior of the shell; but after killing the animal in hot water, and extracting it from the shell, the little free perforated process is distinctly seen, and is then about 2 millim. in length, its dimensions having been, doubtless, much contracted by the hot water.

The genus *Spiraculum* of Pearson was established upon the species *S. hispidum*, P. By Dr. Pfeiffer that species has been referred to *Pterocyclos*, to which it is certainly nearly allied, although there appear to be good reasons for its generic separation. I have never had an opportunity of examining the animal of *S. hispidum*; but in the autumn of 1861 I met with a second species of the same genus in the neighbourhood of Ava (*S. avanum*, mihi). This species is furnished with a small tube similar to that in *S. hispidum*, opening at both ends, internally inside the body-whorl, close to the suture and at a short distance behind the peristome, and externally into the air, the short tube on the exterior of the whorl being free and curved backwards. The individual which I examined was just adult; there was no tubular process of the animal, but it was replaced by a deep notch in the mantle corresponding to the perforation of the shell. It is possible that, in older specimens, this notch may become altered into a more or less perfect tube; but, as the specimen examined was full-grown, this is scarcely probable.

The other tube-bearing genera with open tubes are *Streptaulus*, which can scarcely be considered as generically distinct from *Raphaulus*, and *Opisthoporus*. I have not been able to examine the animals of either of these. The tube in the aberrant genus *Alycæus* opens anteriorly into the body-whorl by a longitudinal slit, as in the other genera; but after running back along the exterior of the suture for a greater or less distance, corresponding with the inflated portion of the last whorl, it is closed at the posterior termination. I have seen the soft parts of several species, including the comparatively large *A. umbonalis*, Bens.,

* This is doubtless the reason that the tubular process of the mantle was overlooked by so careful an observer as Mr. Benson, who, I believe, confined his observations to the living animal. (See Ann. & Mag. Nat. Hist. ser. 3. vol. iv. p. 94.)

but have been unable to detect any organization corresponding to the shelly tube.

It was long since observed by Mr. Benson that no portion of the animal of *Pterocyclos* appeared to correspond with the peculiar incision of the inner, and cowl-shaped process or wing of the outer, peristome. I have examined two or three species* of that genus with precisely the same result. Amongst the Pupinidæ, I have examined the animals of a variety of *Pupina artata*, Bens., and of *Hybocystis gravis*, B., but I could detect no trace of any process similar to that in *Raphaulus*.

The question of the use of these peculiar tubes in several genera of Indian Cyclostomacea, and the reason of their existence in only a few forms belonging to two different families (Cyclophoridæ and Pupinidæ) and by no means closely allied, has always appeared to me of considerable interest. The first and most natural suggestion which would occur to any one is that the tubes in question serve to supply the animal with air when the mouth of the shell is closed by the operculum. But, natural as this explanation seems, and despite its apparent confirmation by the discovery of the perforated process in the animal of *Raphaulus*, as described above, a very short consideration will show the difficulty of accepting it. For if additional means of breathing during æstivation are essential to *Raphaulus* and *Spiraculum*, how do forms so closely allied to them as *Pupina* and *Pterocyclos* contrive to exist without them? And this is the more inexplicable because there are modifications of the shelly portions of those genera which apparently represent the sutural tubes of *Raphaulus* and *Spiraculum*, the close relation of perforations in the body-whorl and slits in the peristome being shown by such genera as *Scissurella*, *Haliotis*, and *Stomatia*, *Fissurella* and *Emarginula*, &c. Above all, what explanation can be adopted for the tube in *Alycaeus*, perforated throughout its length, but closed at its posterior termination?

It is extremely probable that there is a connexion between the existence of the sutural tubes in the land-shells mentioned and the well-known siphon of *Ampullaria*, which genus, from its habit of æstivating in the dried mud of tanks, and its power of living for months without water, may almost be considered as an amphibious mollusk, and which approaches the Cyclostomacea most closely in the form of the animal. Another siphon-bearing species is *Camptonyx*, Bens., allied to *Otina*, which is by most conchologists classed with the amphibious Auriculacæ, and I have recently obtained in Western India another generic type

* Amongst others, *Pterocyclos pullatus*, Bens., from Pegu, *P. nanus*, B., from the Nilgiris, and a species (a variety, perhaps, of *P. Albersi*, Pfr.) from Arrakan.

similarly furnished. It is closely affined to *Camptonyx*, being intermediate between that genus and *Succinea*. The two last-named shells æstivate attached to rocks. I am inclined to think it possible that links yet remain to be discovered between all the siphon- and tube-bearing genera, in which the peculiar organization, common under various modifications to all of them, is more clearly adapted to the animal's mode of existence than in the cases mentioned. It is extremely probable that such links may have existed and have become extinct. We can on this hypothesis easily conceive that their living representatives or, on the theory of Darwin, their modified descendents possess the organization, in a more or less perfect condition, which was essential to their predecessors, but is no longer equally necessary to their own existence, and that, in short, the various apertural slits and imperforate tubes of *Pterocyclos*, *Pupina*, *Alycaeus*, &c., must be regarded in the same light as rudimentary organs. By this hypothesis, also, we can understand the appearance of the more perfect conditions for communication between the atmosphere and the lung-chamber of the animal in widely separated forms, while others closely allied to each of them are more or less deficient in all traces of a similar organization, and the occurrence of a gradual passage from tube-bearing genera to others totally destitute of any modification of the peristome or suture is perfectly natural. The tube of *Spiraculum* becomes an incision in the peristome in *Pterocyclos*, the Burmese forms of which are closely allied to species of *Cyclophorus* like *C. calyx*, Bens., which have a thickened operculum and a minute rudimentary wing-shaped projection of the outer lip, close to the suture; and from these forms, again, there is a passage to discoid species, like *C. stenostomus*, Sow., with perfect peristomes. In the same way we may pass from *Raphaulus*, through *Pupinella* and *Pupina*, to *Registoma*, and finally to *Callia*, and through *Cataulus* to *Megalomastoma*. To the subject of the affinities of these various genera, however, and especially of the aberrant *Alycaeus*, I hope to refer in a future communication.

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BIBLIOGRAPHICAL NOTICES.

A List of the Birds of Europe. By Professor J. H. BLASIUS. Reprinted from the German, with the author's Corrections. Norwich: Matchett & Stevenson. London: Trübner & Co. 1862.

PROFESSOR J. H. BLASIUS, of Brunswick, is well known to the scientific world as one of our very highest authorities on European Vertebrates. His *Manual of the Mammals of Central Europe* is certainly the best of modern works on this subject; and the second volume of